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ABSTRACT

During the last decades, a shift from studying the product to studies of the processes has become more and more obvious. The major aim of this study was to investigate the mental performance process and to examine the changes the variables describing this process undergo with time. In this investigation, a mental arithmetic test was used. The test was given to the same 50 girls and 74 boys each year from grades three through six. The following variables were examined: (1) the level and the fluctuation of the performance process: (2) the percentage of correct answers: and (3) the slope of the regression line. The level of the performance process is found to develop as an S-shaped curve. It is also found that the often reported greater fluctuation for boys than girls in the performance process is solely due to the neglect of taking the main trend of the curve-of-work into account. The results further indicate that girls are more persistent than boys, in agreement with other studies. No significant sex differences are reported. (Author/MK)

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CONTINUITY IN CHANGE IN THE MENTAL PERFORMANCE PROCESS.

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Running headline: The performance process

Paper presented at the Fifth Biennial Conference of the International Society for the Study of Behavioral Development, Lund, Sweden. 1979.

ABSTRACT.

During the last decades a shift from studying the product to studies of the processes has become more and more obvious. The major aim of this study was to investigate the mental performance process and to examine the changes the variables describing this process undergo with time.

In this investigation a mental arithmetic test was used. The test was given to the same 50girls and 74 boys each year from grades three through six. The following variables were examined:the level and the fluctuation of the performance process, the percentage of correct answers and the slope of the regression line.

The level of the perfomance process is found to develop as an S-shaped curve. It is also found that the often reported greater fluctuation for boys than girls in the performance process is solely due to the neglect of taing the main trend of the curve-of-work into account. The results further indicate that girls are more persistent than boys, in agreement with other studies.

No significant sex differences are reported.

The test instrument is composed of 528 items. The items have to be solved mentally according to special rules. The two rows should be calculated separately and the results compared. If the results from the lower row is smaller than the result from the upper row, a subtraction has to be done. In the opposite case, the results from the two rows should be added.

igure 1.

After the children received this instruction they did some practice exercises, had a recess break and then took the test. In order to get information about the curve-of-work the children were asked every third minute to indicate on the test how far they had gotten. These 3-minute intervals are called periods here and the test time consisted of 14 periods - a total of 42 minutes.

Subjects.

The KUP-test was given to all the children participating in the longitudinal Swedish project. They were born in Solna, A Stockholm suburb, during 1955-58. The sample, consisting of 212 children, has been found to be a representative sample of Swedish urban children (Karlberg et al. 1968). At the age of ten years these children were given their first KUP-test and thereafter each year for three more years.

In my analysis of the results only data from students who were present at all four test occations are included. This policy, however, reduced the total sample with about 40%, the final test group amounting to 50 females and 74 males. A test of the representativeness of this group showed no differences between the test group and the drop-out group (Drakenberg, 1978).

RESULTS.

4

igure 2.

Figure two gives an overview of the curves-of-work obtained in this study.

However, in most studies on curves-on-work (Kraepelin,1902; 1922; Pauli, 1936; 1938; Heikkinen, 1952; and Reuning, 1957; 1958;), the number of variables needed to explain the curve-of-work has been great many. Most of these variables have been poorly characterized, do often overlap each other and many of them were found to be of little importance in the understanding of the performance process (Drakenberg,1978). Therefore, only four variables will be presented here. They are: the level and the fluctuation of the performance process, the percentage of correct answers and the slope of the regression line.

The level of the performance.

The number of correctly answered items per 3-minute period has been used as a measure of the performance level. From Figure 3 it can be seen that there are no sex differences in the performance level but that there is a continual increase from grade to grade in the performance level. This increase, however, is not of the same magnitude in every grade. Between grades 4 and 5, when the children are eleven to twelve years old, there is a significantly smaller increase ($p \leq .05$) than between grades 3 and 4 and between grades 5 and 6, respectively. Thus, the development of the performance level can be described as an S-shaped curve. Such a curve has also been found for mental development (Siegwald,1944; and Ljung, 1965;) as well as for physical development (Siegwald, 1944; and Westin-Lindgren, 1979). It is, though, important to emphasize that no single curve of development can be fitted to the whole period of life. For such a purpose it is"necessary to construct a composite curve consisting of several phases or cycles" (Wohlwill,1973,p.169)

igure 3.

The fluctuation of the performance process.

This variable has been utilized to measure the variation - the ups and downs - in the performance process. Generally the standard deviation of the mean value over periods has been used as a measure of this fluctuation. Measured in this way, as can be seen in Table 1, the fluctuation tends to be greater, although not significantly, for boys than girls. An increase from grade to grade in the fluctuation was also observed. However, such an increase was expected, due to the fact that the standard deviation is somewhat dependent on the level of the the performance means. Thersfore such a measure of the performance fluctuation was considered of little interest. Another way of measuring the fluctuation is to use the variation around the regression line - a regression line obtainable from the curve of-work. As found in Table 2, studied in this way the fluctuation of the performance showed very little changes with age as far as the boys are concerned. In grade 3 and 4 there is no sex difference. The results in grade 5 and 6 indicate a tendency toward greater fluctuation for girls, although no significant difference between the sexes were found.

Table 1.

Table 2.

This way of measuring the fluctuation of the performance process has been found more appropriate and therefore preferred here because of the falling trends of the curves-of-work obtained in this study (see Figure 2). It is considered important to take trend of the process into account when studying the fluctuation in the performance process.

The percentage of correct answers.

The percentage of correct answers can be regarded as a measure of the power of the children's concentration. As can be seen in T able 3 the per-

Table 3.

centage of correct answers is growing continually from grade to grade, being mostly somewhat higher for girls than boys.

As it is possible to use this variable not only as a sum total but, in addition, as a process variable, its variation during the test time has also been studied. As can be seen in Figure 4 there is no significant

Figure 4.

difference between boys and girls in this respect. The findings also indicate that the children's concentration is at about the same level throughout the whole testing time. Only a slight, random variation is found in the course of the 42 minutes, which is perceived as a rather unexpected result. Thus, it is obvious that the children, instead of making more mistakes when they get tired, slow down their speed, so that the solution accuracy stays at about the same level throughout the whole testing time.

The slope of the regression line.

The regression line is obtained from the curve-of-work. Its slope has here been utilized as a measure of the children's persistence. And in order to make comparisons possible between curves-of-work on different levels of performance, the slope has been normalized as regards the level of perfor-

Table 4.

mance. As can be seen in Table 4, the girls tend to be more persistent than the boys. This sex difference is, however, not significant. The results also indicate that the slope of the regression line is continually increasing from grade to grade, which means that both boys and girls tend to become less persistent on this type of tasks as they grow older.

CONCLUDING DISCUSSION.

At a compariosn between these results and the results from other investigations using the same variables, certain differences are clearly perceptible. Compared to studies using the same test, but a cross-sectional method,

the level of performance has been found to be much higher in this strictly longitudinal study. The S-shaped growth curve here found is an important finding, and seldomly found in cross-sectional studies. This might indicate that the use of the longitudinal method not only makes it possible to use stronger statistical methods in the data analysis but, above everything, gives a more accurate picture of human development (Boruch, 1976).

In previous investigations on curves-of-work the standard deviation has been used to describe the fluctuation in the performance process. As such a measure does not take into account the overall trend of the process it is considered not satisfactory for the purpose of this study. The variation around the regression line was proposed as a more suitable measure. Measured in this way it was found that the previously found larger fluctuation for boys as compared to girls disappears. The fact that other researchers have found sex differences in this respect is most certainly due to their disregard of the overall shape of the performance process.

In this study it was also found that both boys and girls tend to decrease steadily in persistence as they grow older. Such a result, though, is most probably caused by the longitudinal method here used.

Unfortunately, it has not in this investigation been possible to differentiate between the impact of practice and the impact of age on the performance process. Therefore, to be able to supply a safer basis for discussions on the performance process and the changes this process undergo at successive ages, such a study is now underway.

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Table 1.

The fluctuation in the number of correct answers for boys and girls in grades 3-6.

Grade	Boys	Girls
3	0.64	0.46
4	1.18	0.85
5	1.67	1.20
6	2.16	1.65

Table 2

The fluctuation in the number of correct responses for boys and girls when the falling trend in the curve of work is taken into account

Grade	Boys	Girls
3	0.36	0.33
4	0.29	0.29
5	0.33	0.55
6	0.35	0.47

Table 3

The percentage of correct answers for boys and girls in grades 3 - 6.

Grade	Boys	Girls
3	80	78
4	81	86
5	83	87
6	86	89

Table 4

The persistence on task for boys and girls in grades 3-6

Grade	Boys	Girls
3	-0.027	-0.011
4	-0.038	-0.020
5	-0.052	-0.038
6	-0.050	-0.042

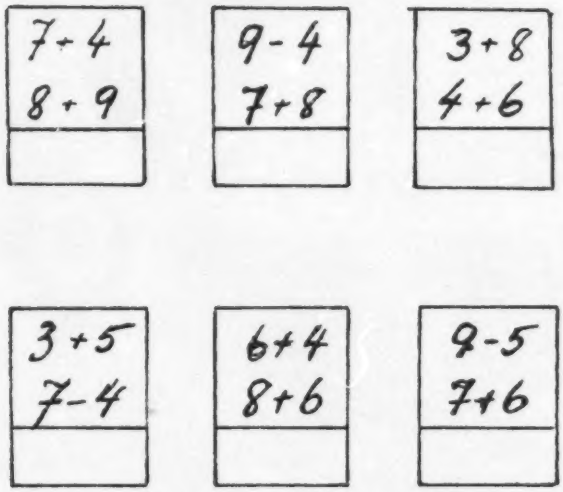


Figure 1

An example of test items in the KUP-test

Figure 2.

Number of items correctly answered per 3-minute period (T), of the Curves of Work. Solid lines and filled symbols for boys and broken lines and open symbols for girls. △ grade 3, □ grade 4, ○ grade 5 and ▽ grade 6.

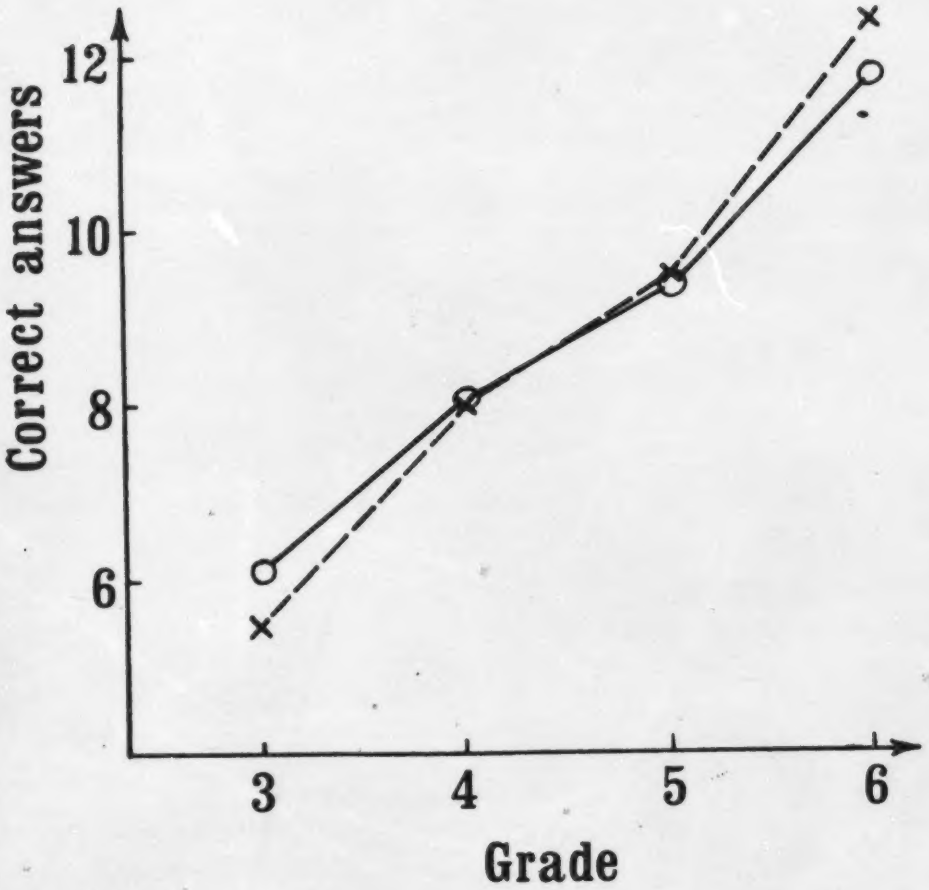

Correct answers
12
10
8
6
3
4
5
6
Grade

Figure 3.

The performance level in grades 3 through 6 for boys (o——o) and girls (x---x).

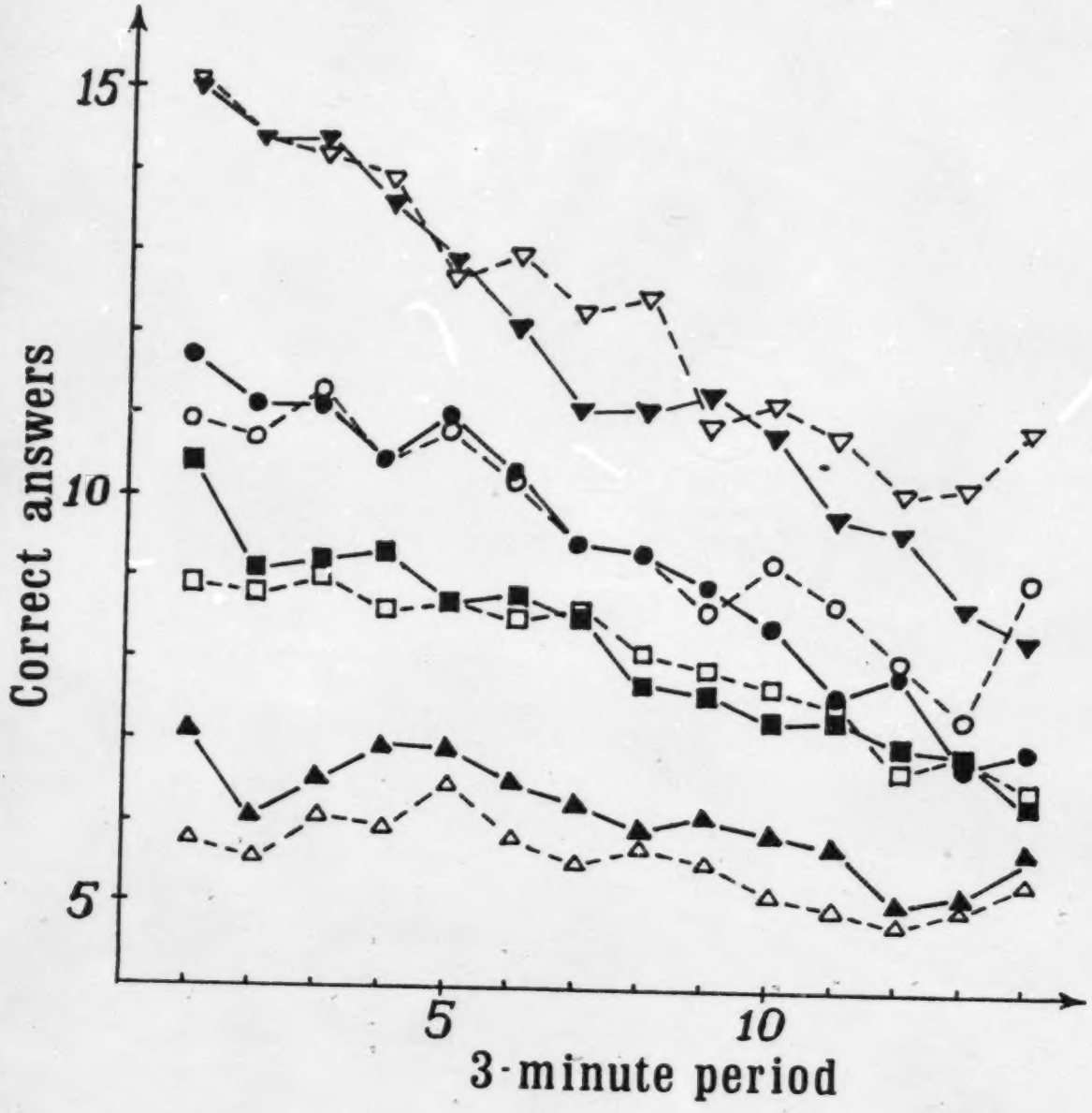
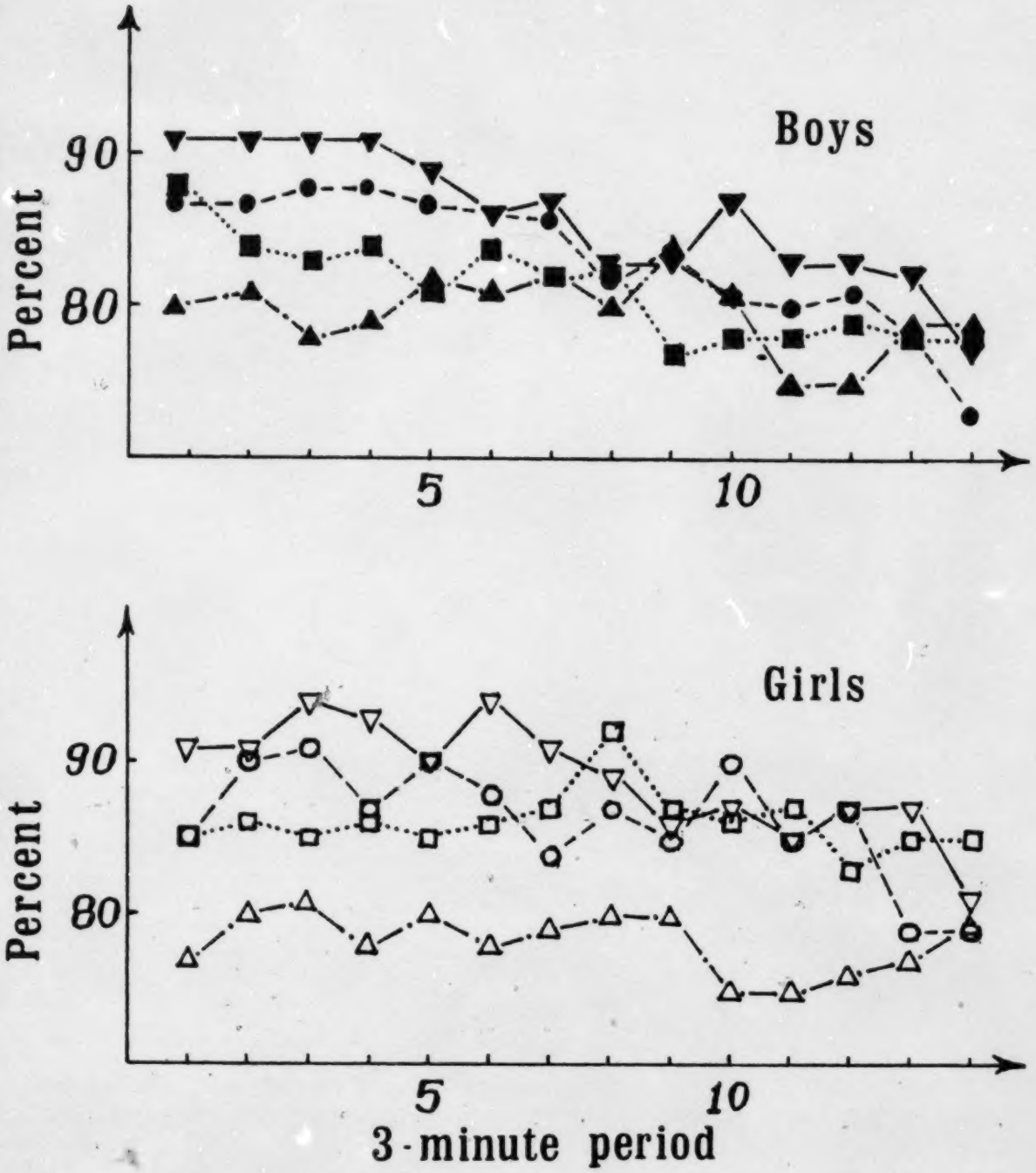

15
10
5
Correct answers
5
10
3-minute period

Figure 4

The percentage of correct responses (P) during the fourteen 3-minute periods. △ grade 3, □ grade 4, ○ grade 5 and ▽ grade 6.


Boys
Percent
90
80
5
10
Girls
Percent
90
80
5
10
3-minute period